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The ROLI Seaboard: Toward A New Understanding of Musical Interfaces

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Abstract

In the realm of music technology, the concept of interfacing with technical objects has largely been examined with a singular focus on physical components (buttons, dials, keyboards, etc.) Despite the utility of a technocentric emphasis, musicologists and STS scholars have shed light on how the designs of musical interfaces are inextricably linked to cultural perceptions and relevant social groups. However, two decades of growth in MIDI controllers and computer synthesis software created new realities that weakened the social determinist view of electronic instruments. This paper seeks to argue for an expanded conceptualization of how musicians interact with musical instruments, whereby software, hardware, and cultural components are analyzed as equal actors constituting the entire interaction during a musical performance. This argument is demonstrated through an empirical analysis of the ROLI Seaboard, an instrument that challenges the boundaries between electronic and classical music, digital and physical technologies, and general and technical usages. This study applies the theoretical framework of Actor-Network Theory to explore the ways, by which heterogeneous elements contribute to the totality of interface design. Also, the analysis utilizes an ethnographic methodological approach to understand the network in question. The research is performed through engaging in community discussions and conducting expert interviews. The framework presented in this research could be applied to the study of a number of newly emerging musical interfaces.

Introduction

The field of music technology and musicology shared a sustained interest in the study of musical interfaces. While the former invests itself in the technicalities of engineering, the latter concerns questions of how social-cultural values shape the designs of interfaces.[1] Simultaneously, Science and Technology Studies (STS), staying true to its interdisciplinary nature, continually pushes the boundaries of sociological, philosophical, and anthropological approaches to the realm of science and technology.[2] STS has been critical in fostering connections between the technical and sociocultural aspects of musical interfaces. Notable works by Hennion,[3] Théberge,[4] Frith,[5] and many other STS scholars have inspired innovative theories regarding musical sound and technological mediations. Moreover, pioneering scholars in the field of STS have contributed significantly to the development of Sound Studies, an interdisciplinary field examining sound, music, and new technology.[6] As such, STS offers a wealth of knowledge pertaining to the interconnectedness of technology, music, and society.

Guided by the STS framework of Actor-Network Theory (ANT), and drawing upon the historical backdrop of music technology, the present research seeks to expand the way engineers and musicologists conceptualize musical interfaces in an era of digital music instruments. More than two decades of technological changes created new realities distinct from many of the previous research. New trends in the development of electronic music, namely the proliferation of computer synthesis software and MIDI controllers, have arguably created drastic changes to the technical and cultural landscape of contemporary digital music.

As Pinch and Bijsterveld noted, "the introduction of new technologies into music (could be seen) as a set of 'breaching

[1] Dolan EI (2012) Toward a musicology of interfaces. Keyboard Perspectives 5: 1–12.
[2] Sismondo S (2011) Introduction to Science and Technology Studies. John Wiley & Sons.
[3] Hennion A and Muecke S (2016) From ANT to Pragmatism: A Journey with Bruno Latour at the CSI. New Literary History 47(2–3): 289–308. DOI: 10.1353/nlh.2016.0015.
[4] Théberge P (1989) The 'sound' of music: Technological rationalization and the production of popular music. New Formations 8: 99–111.
[5] Frith S (1986) Art versus technology: The strange case of popular music. Media, Culture & Society 8(3). Sage Publications: 263–279.
[6] Pinch T and Bijsterveld K (2004) Sound Studies. Soc Stud Sci 34(5): 635–648. DOI: 10.1177/0306312704047615.

experiments.""[7] Such breaching experiments reveal established norms and values delegated to both humans and technology. Under this approach, the paper examines how a new musical instrument, the ROLI Seaboard, breaches traditional understandings of interface design and reveals a network of cultural, technological, and human relationships.

The ROLI Seaboard

In a 2013 interview with CNN, renowned soundtrack composer Hans Zimmer was seen playing an odd-looking instrument. Viewers observed how the tonality of the sounds changes and evolves as Zimmer wiggles his fingers up and down the controller. With just the two hands of the composer, a grand orchestral symphony is recreated via an almost alien technology. The dark, rubbery, and keyboard-shaped invention is the first generation of the ROLI Seaboard, or as the article called it, the "piano of the future".[8]

Hans Zimmer, who is lauded for his fusion of orchestral and electronic elements in soundtracks, is perhaps the best human embodiment of the Seaboard. Like Zimmer, the avant-garde instrument also seeks to fuse the tactile expressiveness of classical instruments with the software technologies afforded by modern digital music. It achieves this by allowing musicians to articulate various musical gestures by pressing, striking, sliding, wiggling, and gliding the finger across the wave-like keyboard.[9] But this is perhaps where the similarity ends. While Hollywood embraced Zimmer's electro-orchestral fusion,[10] the Seaboard failed to achieve the rate of adoption as envisioned by its makers. On September 3rd, 2021, ROLI, the company renowned for producing the innovative controller filed for bankruptcy. Roland Lamb, founder of ROLI attributed the bankruptcy to the company's pursuit of hypergrowth in the face of a niche marketplace.[11]

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[7] Pinch T and Bijsterveld K (2004) Sound Studies. Soc Stud Sci 34(5): 635–648. DOI: 10.1177/0306312704047615.

[8] McNicoll A and CNN B (2013) Hans Zimmer Plays the Piano of The Future | CNN Business. Available at: https://www.cnn.com/2013/09/27/tech/innovation/hans-zimmer-seaboard-future-piano/index.html (accessed 26 June 2022).

[9] Symons M (2018) ROLI Seaboard Block Review: A Full Band in A Squishy, Portable Package. Available at: https://www.imore.com/roli-seaboard-block-review-full-band-squishy-portable-package (accessed 25 June 2022).

[10] Lehman F (2016) Manufacturing the Epic Score: Hans Zimmer and the Sounds of Significance.: 41–70. DOI: 10.4324/9781315690025-10.

[11] Ghosh S (2021) Pharrell- And Grimes-backed Music Startup Roli Files for Administration and Reboots as Luminary to Refocus on Beginner Musicians. Available at: https://www.businessinsider.com/roli-administration-luminary-hoxton-seaboard-lumi-music-2021-9 (accessed 4 July 2022).

Seaboard, along with other expressive controllers, were proclaimed to bring about the future of electronic instruments. The juxtaposition between this grand vision and the instrument's slow adoption highlighted multiple hindrances preventing an unobstructed interaction with the Seaboard. Such hindrances, as the essay shall later explore, reveal a need for recognizing musical interfaces as an amalgamation of hardware, software, and cultural components. But before that, an analysis of the historical development that differentiated 21st- century digital music interfaces with acoustic and analog instruments are required.

Literature Review: A Chasm between Sound and Interface

Schizophonia, a term coined by R. Murry Schafer in 1969 described the growing phenomenon of sound being increasingly dislocated from the physical object that engendered it.[12] The chasm between sound and its point of production has been a continual trend in musical history, present in multiple periods of technological change. The advent of new recording technologies, modern orchestration, innovation in analog synthesizers, and many other events served to widen this dislocation.[13] For this section, I want to illustrate how the phenomenon of schizophonia is taken to an entirely new level due to the simultaneous development of two key technologies, the MIDI protocol, and personal computers.

I. Bridging Computers and Instruments: the MIDI Protocol

MIDI, short for Musical Instrument Digital Interface, is a digital communications specification that standardized the transmission of musical data across musical technologies. It is important to note that MIDI itself is not music or sound, but a common communications standard that allows instruments and software to "talk" to each other.

Owing largely to the joint collaboration of leading manufacturers of commercial synthesizers such as Sequential Circuits, Roland, Korg, and Yamaha.[14] The MIDI protocol became one of the quickest communication standards to be widely adopted. Three years after its initial inception, most synthesizer companies already adopted MIDI as a communication standard for their products.[15]

[12] Schafer RM (1994) The Soundscape: Our Sonic Environment and the Tuning of the World. 1977. Rochester, VT: Destiny Books 12
[13] Dolan EI (2012) Toward a musicology of interfaces. Keyboard Perspectives 5: 1-12.
[14] Holmes T (2015) Electronic and Experimental Music. Routledge.
[15] Manning P (2013) Electronic and Computer Music. Oxford University Press.

The successful establishment of the MIDI protocol prompted a wave of new MIDI-based digital synthesis products that gradually outcompeted manufacturers of analog synthesizers, setting the stage for the growth of computer music software and complementary hardware controllers.

II. From the Physical to the Virtual: Personal Computers and Music Software

The dream of a machine that could process, manipulate, and output music could be traced back to the very beginning of computing history. In 1843, Ada Lovelace, widely regarded as the world's first computer programmer, envisioned an engine that could "compose elaborate in scientific pieces of music of any degree of complexity".[16] More than a century later, this dream would begin to be realized, starting with the advent of the personal computer.

Beginning in the early 1980s, the market shifted from favoring expensive and large machines to smaller and accessible personal computers. Increased accessibility of computers for musicians inspired research into technologies that could fulfill the demand for musical creativity.[17]

The advancements in hardware are quickly accompanied by developments in software-based music applications, including audio recording systems, synthesis, and audio processing software. One notable example of such virtual music-making programs is CSOUND, a software that enables the real-time synthesis of electronic sounds. When combined with MIDI technologies, the software effectively becomes a programmable virtual synthesizer. This approach quickly opened the possibility of creating more software-simulated instruments.[18]

Apart from playing virtual instruments, early programs such as Protools and Cubase expanded the possibilities of computer music by allowing users to arrange audio recordings and host multiple computer instruments/effects. The latter development was pioneered by Steinberg, which introduced Virtual Studio Technology (VST), a digital interface standard that allowed for the running of multiple software instruments as modules in a single digital audio environment.[19] One early example of

[16] Isaacson W (2015) Innovators. Simon and Schuster.
[17] Holmes T (2015) Electronic and Experimental Music. Routledge.
[18] Manning P (2013) Electronic and Computer Music. Oxford University Press.
[19] Model E, VST instrument by Steinberg (n.d.). Available at: https://freevsts.com/steinberg-model-e/ (accessed 5 July 2022).

a VST instrument is the Model E, which emulated the famous analog synthesizer, Minimoog.[20]

The rapid technological innovation in computer music created a significant impact on the music industry. According to Holms:

> By the year 2000, the availability of increasingly affordable memory and processing power led to a wholesale migration of computer music activity to the desktop or laptop platform, broadening its reach and appeal well beyond academia into all genres of music.[21]

The appeal of an integrated software music environment is self-evident. Users could flexibly switch between their VST instruments, add audio effects, and conduct audio manipulation without the need for complex physical wiring and expensive hardware.

However, one disadvantage of software interfaces is becoming increasingly apparent, the lack of interfacing hardware. Using the mouse to tweak parameters and the QWERTY keyboard to play notes made computers undesirable instruments to perform with. As such, a new generation of electronic music controllers that focuses solely on the sending of MIDI data to virtual instruments emerged.

These instruments are referred to generally as MIDI controllers, instruments that are designed to be connected to virtual instruments on a computer and contain no sound generators. Thus, they could not produce sounds independently. A performer who interacts with the controller generates MIDI data which triggers sounds on the computer software.

The cheap production cost of MIDI controllers, in combination with ever more accessible software technologies allowed for a democratization of music making.[22] As Huber explained, "The MIDI keyboard controller has grown in popularity, to the point that it is standard in most production setups."[23]

When taken together, it's easy to see how a proliferation of software technologies and MIDI keyboards ushered in a new era of

[20] Manning P (2013) Electronic and Computer Music. Oxford University Press.
[21] Holmes T (2015) Electronic and Experimental Music. Routledge.
[22] Gosling E (2020) How Design Is Helping to Democratize Music Making | Adobe XD Ideas. Available at: https://xd.adobe.com/ideas/perspectives/social-impact/how-design-helps-democratize-music-making/ (accessed 5 July 2022).
[23] Huber DM (2020) MIDI Manual 4e. Routledge.

musical interfacing. The physical instrument is increasingly entangled in a dependency on software infrastructures. A phenomenon where sounds are further separated from their physical origin. In STS, it is widely agreed that sound is the key mediator for musical experiences.[24] As such, in an era of digital music, a singular understanding of interface as solely the physical object is inadequate. Our understanding should instead include a network of factors that the instrument is dependent upon. This demands an inquiry into the cultural and technical relationships between the various components that constitute the entire interface: how do users interact with the hardware? How do users interact with the software? How do hardware and software systems interact? How do cultural perceptions shape the users? In the following analysis, I shall demonstrate how each of these questions is equally important to the Seaboard interface.

STS Framework

Actor-network theory, an STS framework developed by Latour, Law, and Callon during the 1980s, states that all situations could be seen as the product of an interconnected network of heterogeneous elements. Each component (actant) within the network should be regarded as equally important. Actor-network theory is especially applicable to framing a new conceptualization of musical interfaces for multiple reasons.

First, actor-network theory suggests that both social and technical factors are equally involved in the construction of artifacts.[25] This concept is explored early on with Law and Callon's network analysis of the TSR 2 British military aircraft project. The analysis illustrated how technical challenges such as an aircraft's weight and sociopolitical demands such as the need for long-range aircraft simultaneously served to shape the technical artifact.[26] The same concept could be extended to the ream of music, where "techniques, settings, and devices exchange their properties with humans."[27] This is indeed true for the creation and designing of musical interfaces, as both technological innovation and

[24] Born G and Barry A (2018) Music, Mediation Theories and Actor-Network Theory. Contemporary Music Review 37(5–6): 443–487. DOI: 10.1080/07494467.2018.1578107.
[25] Latour B (2007) Reassembling the Social. OUP Oxford.
[26] Law J and Callon M (1988) Engineering and Sociology in a Military Aircraft Project: A Network Analysis of Technological Change. Social Problems 35(3): 284–297. DOI: 10.2307/800623.
[27] Prior N (2008) Putting a Glitch in the Field: Bourdieu, Actor-Network Theory and Contemporary Music. Cultural Sociology 2(3): 301–319. DOI: 10.1177/1749975508095614.

cultural expectations are key factors in determining the development of interfaces.

Second, ANT focuses on the associations between actors, and how these interactions create value. A single actor is not significant in and of itself.[28] Music is created through the interactions that composers and performers form with instruments and technologies, an instrument would not produce sounds without a human actor, and neither could musicians without instruments.

Third, an actor-network "stabilizes" when the associations between various actors solidify and become organized. As John Law has suggested, "the stability and form of artifacts should be seen as a function of the interaction of heterogeneous elements as these are shaped and assimilated into a network".[29] The concept of stabilization is central to the mass adoption of new musical equipment, as musicians accept the new technology as an established part of musical culture. During the 19th century, linked-key mechanisms and valves are first introduced and applied to woodwinds and brass instruments. This technology was met with "opposing opinions and the sustained discussions about the … disadvantages of those technical innovations."[30] Fast forward to the present day, the technology is widely accepted as a part of woodwind instruments, as such the musical technology has "stabilized". In this research, the same concept of actor-network and stabilization will be applied to the ROLI keyboard. An analysis of the actor-network of a Seaboard reveals different elements that contribute to or obstruct the stabilization of the interfacing experience. Furthermore, tracing the development of the ROLI Seaboard allows us to visualize how connections between a collection of actors change over time, which could help inform us about future improvements that could potentially enhance Seaboard's interface.

Finally, ANT introduces the concept of "heterogeneous engineers", innovators who "seek to associate entities that range from people, through skills, to artifacts and natural phenomena."[31] Under this

[28] Law J (2004) After Method. Routledge.
[29] Law J, Bijker W, Hughes TP, et al. (2012) Technology and heterogeneous engineering: The case of Portuguese expansion. The social construction of technological systems: New directions in the sociology and history of technology. MIT Press Cambridge, MA: 105–127.
[30] Ahrens C and Zedlacher I (1996) Technological Innovations in Nineteenth-Century Instrument Making and Their Consequences. The Musical Quarterly 80(2): 332–340. DOI: 10.1093/mq/80.2.332.
[31] Law J, Bijker W, Hughes TP, et al. (2012) Technology and heterogeneous engineering: The case of Portuguese expansion. The social construction of

view, inventions of heterogeneous engineers are best seen as heterogeneous networks that "maintain some degree of stability in the face of the attempts of other entities or systems to dissociate them..."[32] The "strength" of the network against dissociating factors determines the degree of success of an invention. Similarly, designers of music interfaces have to associate multiple actors in order to achieve a relatively stable product. I encourage designers of new musical instruments and controllers to view themselves as heterogeneous engineers and consider the social-technical components involved in their designs.

Research Methodology

To understand the genuine interfacing experience that users had with the Seaboard, as well as the wider cultural perspectives they reserved towards the instrument, an ethnographic approach was taken to procure user experiences. To elicit responses, I entered the forums of ROLI users as well as other communities of electronic music makers. The forums involved in the study include r/synthesizers, a community of people "obsessed with synthesizers: hardware & software," created in 2009, with 242,000 members; r/WeAreTheMusicMakers, a community "for discussing the music-making process - writing, composing, recording, live performance, mixing and mastering," founded in 2008, with 1.8 million members; and r/midi, a forum dedicated to "discussions, questions and general knowledge about the Musical Instrument Digital Interface specification and its implementations," established in 2009, with 6,000 members.

In each community, I initiated discussions about the user's experiences and expectations for the ROLI Seaboard. The first question that I posed seeks to understand the types of users that engage with the Seaboard as well as their interfacing process with the instrument. The second question engages members on their personal views regarding the limitations of the Seaboard.

Apart from understanding the community of users, I interviewed educators and industry professionals to provide further insights into the status quo of computer music and their views on the ROLI Seaboard. The interview is text-based and in some cases, mediated by online

technological systems: New directions in the sociology and history of technology. MIT Press Cambridge, MA: 105–127.

[32] Law J, Bijker W, Hughes TP, et al. (2012) Technology and heterogeneous engineering: The case of Portuguese expansion. The social construction of technological systems: New directions in the sociology and history of technology. MIT Press Cambridge, MA: 105–127.

chatting platforms. Among the interviewees are Rishabh Rajan (faculty in the Electronic Production & Design department, teaches the MIDI specification), Dennis DeSantis (composer, sound designer, percussionist, and author, head of documentation for Ableton), and Matthew Davidson (software interface designer, associate professor, musical user interface designer at MOTU, Cycling '74, and others); Zhao Yi Tian (composer, vice president of the Shanghai Computer Music Association), and Yang Jia (AI music researcher) from the Shanghai Computer Music Association; as well as Roger B. Dannenberg (computer music engineer, Professor of Computer Science, Art & Music at Carnegie Mellon University). These individuals come from various backgrounds (musicians, researchers, and engineers) and cover the perspectives of diverse relevant social groups. Their insights diversified the range of perspectives contributing to the present research, leading to a more holistic and empirical analysis of the Seaboard interface.

Application of ANT to the ROLI Seaboard

The Seaboard alone does not produce sounds. An operational Seaboard requires a synergy between multiple actors: hardware, software, musicians, etc. For a user to smoothly interact with the instruments, all heterogeneous components must be associated.

I. Associating the Seaboard with Culture: Cultural Perception of the Keyboard

Roland Lamb, creator of the Seaboard once described his design philosophy as making "living musical instruments":

> A living musical instrument is ten percent physical, ninety percent cultural… Say you go to a museum and see some old instrument, but nobody knows how to play it or what the music was like that was made with it. Then it's just a dead object.[33]

Being aware of how cultural perceptions influence musical interfaces, the first sets of heterogeneous components that the engineer associated together is the physical design of the Seaboard and wider cultural perceptions regarding musical interfaces.

ROLI presented the Seaboard instrument as striking the ideal balance between opposing sets of values in instrument design, "(The

[33] Vincent J (2015) Feeling the Music with Roli's Squishy, Pressure-sensitive Keyboard. Available at: https://www.theverge.com/2015/9/23/9372961/roli-seaboard-rise-grand-hands-on (accessed 27 June 2022).

Seaboard GRAND) has the timeless elegance and enduring solidity of an older instrument. But after one moment of touch, you'll know that it's part of the future."[34] Indeed, the physical interface of the Seaboard simultaneously contains elements of discreetness and continuity in design. It is discreet in the sense that by morphing together notes into one continuous wave-shaped surface, the Seaboard is suggestive of separating itself from the "MIDI keyboard" design format that has permeated through the digital music culture. When musicologist Emily Dolan explored the cultural perception surrounding the keyboard interface, she concluded that "in the quest to create a keyboard instrument with ever greater nuance and control, the keyboard becomes itself a model of control and organization."[35] The keyboard, under this view, becomes a cultural manifestation of rigidity, sacrificing musical expressiveness for greater tonal control. Thus, it is not surprising that throughout the history of modern electronic music, numerous engineers have attempted to embark on a crusade of "de-keyboardification". The late 1980s saw the launching of the WX7 MIDI, a controller that sought to disrupt the keyboard paradigm by designing an interface that models the physical characteristics of woodwind instruments. The ZETA violin, introduced in the same decade, used sensors to register vibrations, thus creating a MIDI string instrument controller. Other examples include the MIDI Theremin, the Buchla Lightning, the Hypercello, the Sensor Chair, the Sensor Frame, and the Digital Baton introduced in the 90s, all of which detect and respond to physical movements in nontraditional ways.[36]

The Seaboard, under this view, also follows the cultural desire for "de-keyboardification". By utilizing a continuous wave-shaped surface, the Seaboard has disrupted the rigidity embedded within the keyboard interface, allowing for microtonal expressiveness. This design successfully appealed to musicians who also seek to break away from the cultural trappings of the keyboard format. Such an effect is demonstrated through the responses gained from online discussions, out of the 57 total responses to the question "what kind of people uses the ROLI Seaboard?" 38 users identified themselves as musicians seeking greater expressiveness out of their instrument.

However, when compared to the ZETA violin or the WX7 MIDI, it is blatantly clear that the Seaboard maintains the general

[34] Seaboard RISE 2 | ROLI (n.d.). Available at: https://roli.com/products/seaboard/rise2 (accessed 26 June 2022).
[35] Dolan EI (2012) Toward a musicology of interfaces. Keyboard Perspectives 5: 1–12.
[36] Manning P (2013) Electronic and Computer Music. Oxford University Press.

structure, and the 12 notes per octave layout of a keyboard. As such, the design is not merely a de-keyboardification like so many other interfaces that came before the Seaboard. Instead, the wave-like design is a cleaver reconcilement between expressiveness and control.

The keyboard interface, as explored by Trevor Pinch and Frank Trocco, has played a pivotal role in establishing the success of synthesizer engineer Robert Moog. The keyboard signaled to consumers the instrumentality of their avant-garde modular synthesizer. This design allowed for increased commercialization of the technology to pop and rock bands as the instrument become increasingly adopted by keyboardists. Furthermore, the keyboard layout incentivized a wave of "Switched-On" music, where electronic musicians recreate classical pieces using the Moog synthesizer. The commercial success of these musicians and albums quickly established the synthesizer as a keyboard instrument.[37]

Similar to how Robert Moog drew upon the cultural perception of keyboards as classical instruments to highlight the instrumentality of his synthesizer. ROLI attempt to elicit the same cultural perceptions of the MIDI keyboard as the standard interface for digital music to indicate that the Seaboard is inherently a MIDI technology for electronic musicians. The effect of this strategy is supported by forum discussions, where 23 out of 57 users identified themselves as using the instrument for electronic music practices such as sound design and synthesis.

So far, we have analyzed how the hardware interface of the Seaboard was associated with cultural perceptions. But a singular focus on the hardware components does not fully compass the entire actor-network of the interface, nor does it reveal the destabilizing components that shaped the instrument's development. As such, we must extend our analysis into the dependencies between hardware interfaces and software ecosystems.

II. Assembling the Seaboard with Software

As was outlined in the literature review, the simultaneous development of personal computers along with MIDI controllers created the phenomenon where sound no longer originate from the hardware controller but instead through virtual instruments hosted by digital music software. New music instruments must adapt themselves to the software ecosystem of computer music before they could be utilized with flexibility by musicians. The interfacing process of a musician not only

[37] Pinch T (2009) Analog Days. Harvard University Press.

involves interacting with the hardware surface but also with software parameters, configurations, and mappings.

One of the key linkages between controllers and computers is via MIDI, the digital language that enables the hardware to connect and trigger music events. To understand the agency that MIDI exerts on the network, we must first understand the limitations of this protocol.

In the MIDI architecture, the "note on" message is sent whenever a keystroke is made on an electronic instrument. The message consists of three bites of data indicating the type, pitch, and loudness of a keypress. Since MIDI only allows 7 bits of data to be sent, the value of pitch and loudness must be in a range from 0 to 127.[38] This architecture has, "important implications arising from the underlying requirement that all frequency information must be rationalized in terms of fixed pitch specifications."[39] While this approach to conveying pitch and dynamics successfully models the playing style of the traditional keyboard, it does not correlate well with instruments that involve continuous microtonal changes, such as woodwinds or strings.[40] Relating back to the ROLI Seaboard, it becomes clear how this digital protocol acts as a hindrance in the interfacing process of the instrument. The MIDI has solidified the keyboard paradigm The Seaboard has always triumphed itself in being able to create microtonal changes, its hardware design invites musicians to wiggle, slide and bend notes like a string instrument. As such, the compatibility between ROLI and software is hampered, and engineers must come up with solutions to associate the instrument with software and provide a complete interfacing experience.

One such solution came in the form of an enhancement based on the MIDI protocol, known as MIDI Polyphonic Expression (MPE). Introduced in 2018, the enhancement allowed "music-making products (such as the ROLI Seaboard) to take advantage of this so that musicians can apply multiple dimensions of finger movement control: left and right, forward and back, downward pressure, and more"[41] As more computer software start integrating MPE into their products, the seaboard could be increasingly connected to virtual instruments.

[38] Huber DM (2020) MIDI Manual 4e. Routledge.
[39] Manning P (2013) Electronic and Computer Music. Oxford University Press.
[40] Manning P (2013) Electronic and Computer Music. Oxford University Press.
[41] Keller D (2018) MIDI Manufacturers Association (MMA) Adopts New MIDI Polyphonic Expression (MPE) Enhancement to the MIDI Specification. 28 January.

However, different software companies have varying priorities, resulting in inconsistent degrees of MPE incorporation.[42] [43] [44] [45] This leads many users to be unable to incorporate the Seaboard into their music-making process. Out of 158 responses to the limitations of the Seaboard, 45 cited the lack of software standards and poor integration with virtual instruments as impediments to their user experience.

Furthermore, many digital music-making techniques and virtual instruments are fundamentally incompatible with the playing style of the Seaboard.[46] [47] [48] For example, synthesis methods are "inherently 'note independent'", this process could not be shaped on a Seaboard,[49] and sampling techniques also could not achieve the temporal manipulations required by the Seaboard.[50]

The issues identified in this section highlighted the agency that MIDI and computer music software have on the actor-network of the Seaboard, without a robust connection with music software the Seaboard interface is essentially incomplete. Associating these technologies is also identified as both a technological (the capacity to improve upon existing digital protocols) and an economical (agendas of different software companies) issue.

III. Musical Interfaces: A Fluid Network

Tracing the longitudinal development of the ROLI Seaboard, from its initial conception to the status quo, we see that the network surrounding the instrument is constantly shifting. As new social groups and technologies join the network, an interface begins harnessing expanded functionalities and becomes accessible to different users.

When the Seaboard was first conceived by ROLI, the company's emphasis lies in the creation of innovative hardware. Computer music thrives on being able to leverage a wide range of digital instruments, and the lack of consideration for existing software infrastructure limited the extent to which Seaboard users could interface with virtual instruments.

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[42] Interview with Rishabh Rajan on Jun 23, 2022, conducted via text message
[43] Interview with Matthew Davidson Jun 29, 2022, conducted via video
[44] Interview with Dennis DeSantis on Jun 29, 2022, conducted via text message
[45] Interview with Zhao Yi Tian on Jun 20, 2022, conducted via video
[46] Interview with Zhao Yi Tian on Jun 20, 2022, conducted via video
[47] Interview with Yang Jia on Jun 20, 2022, conducted via video
[48] Interview with Roger B. Dannenberg on Jun 28, 2022, conducted via text message
[49] Interview with Yang Jia on Jun 20, 2022, conducted via video
[50] Interview with Roger B. Dannenberg on Jun 28, 2022, conducted via text message

But as new user groups, corporations and technologies become integral components of the same network, the Seaboard is allowed to expand and evolve. The adoption of the MPE expansion by the MIDI Association and the subsequent incorporation of MPE technologies into software instruments allowed for the interfacing experience of users to slowly stabilize. Although in the status quo, varying levels of compatibility still induce levels of stabilization on the network, future developments such as the potential incorporation of MIDI 2.0 into computer software may bring about greater associations between the various components of the Seaboard network.

Conclusion

As musical interfaces are not simply physical, with the increasing separation between hardware and sound, it is important to consider culture, sound, digital protocols, and software environments as integral parts of a musical interface network.

Conceptualizing a musical interface as a culmination of components in a network has two advantages. Firstly, it highlighted the role of interface designers as "heterogeneous engineers". As the paper demonstrates, the creators of Seaboard carry the responsibility of associating together a multitude of human and nonhuman actors. A simplified understanding of interface as a physical object creates the illusion that an innovative interface could inherently attract success. This thus falls into the same trappings as the early Seaboard experienced. Secondly, analyzing the components surrounding an interface also serves to make visible the hidden agencies exerted by culture and nonhuman actors. By applying actor-network theory to the Seaboard, the cultural perceptions surrounding the keyboard and the effects that the MIDI protocol had on computer music are highlighted.

As hardware instruments and software technologies become increasingly entangled in the web of associations, the framework presented by this research could be applied to a growing number of new musical interfaces. By extension, the findings presented by this paper could be applied to other digital entertainment industries, such as game controllers and virtual reality. These technologies are similarly shaped by diverse cultures and are dependent on software systems to create a complete interface.

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Davidson, Matthew. Video interview. Jun 29, 2022

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